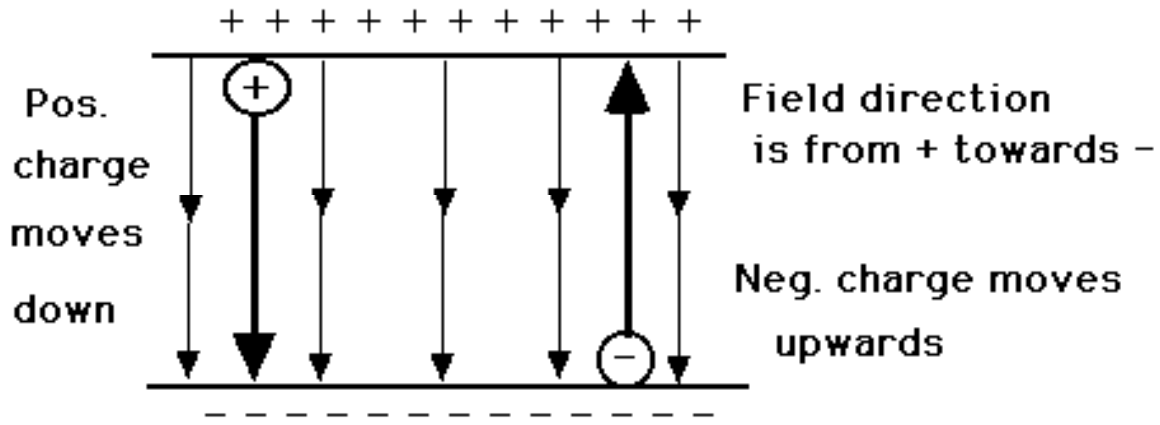
Constant Electric Fields

So far, we have looked at electric fields due to small point charges. Like the gravity of planets and stars in space, the electric field strength of any charged particle decreases with distance, as indicated by the equation

$$\mathbf{E = k\frac{Q}{R^2}} \qquad \text{where} \qquad \mathbf{E \; \alpha \; 1/R^2}$$

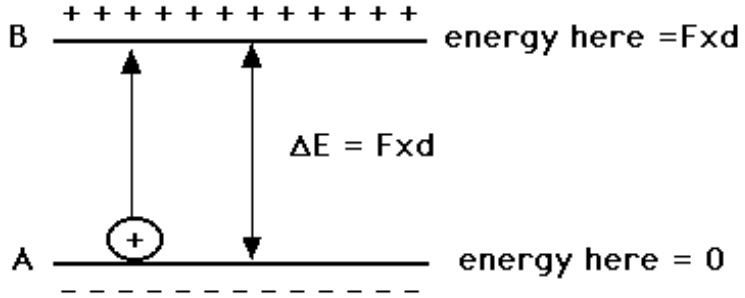
In fact, each of the formulas for $\mathbf{F_E}$, $\mathbf{E_p}$ and **V** show that all of these quantities decrease with increased distance **R** from a given charged particle.

Now we will examine the field between two oppositely charged parallel plates. The field is uniform everywhere between the plates. If a charged particle is placed in such a field (as shown in the diagram below), it will "fall" away from the repelling plate and move towards the attracting plate.



Because the force on a charge is **F = qE**, and since the electric field E is constant between the plates, the force on a charge is the same wherever that charge is located between the plates. In other words, '**R**' is irrelevant!

Now examine a single positive test charge moved from plate **A** to plate **B** as shown in the following diagram:



Since the test charge has been moved across the space between the plates, against the field, work has been done against the field, producing a gain in potential energy, shown as $\mathbf{W = \Delta E_p = Fd}$.

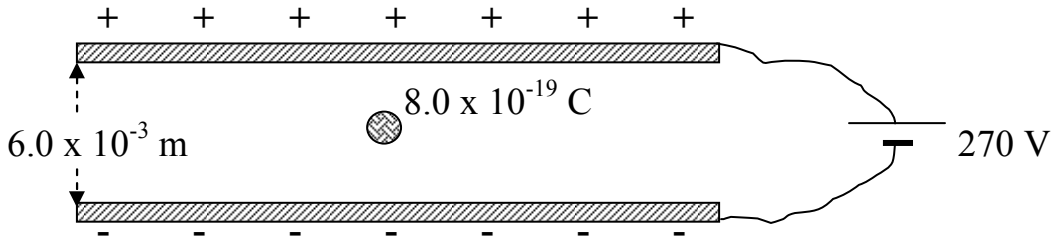
This knowledge can be used to find the electric field strength between the plates. Recall that **potential difference** or **voltage** ($\mathbf{V_{ab}}$ or $\Delta\mathbf{V}$) is simply the change in potential energy per Coulomb of charge as a charge moves between two charged plates in a uniform electric field.

From the definition, voltage $\mathbf{\Delta V = \frac{\Delta E_p}{q} = \frac{Fd}{q}}$ and $\mathbf{E = \frac{F}{q}}$

→ so $\mathbf{\Delta V = Ed}$ or $\boxed{\mathbf{E = \frac{\Delta V}{d}}}$

The units for electric field strength: **Volts/metre (V/m)** …yeah, I know this was already done but its good review so what the hey…

Example 13. A charged particle of 8.0 x 10^{-19} C is held stationary inside an electric field produced by two electric plates. The voltage between the plates is 270 V and they are separated by a distance of 6.0 x 10^{-3} m.



a) **What constant electric field strength exists between the plates?**
b) **What is the mass of the particle? Hint: first draw a f.b.d. of the particle to determine its weight.**

(see Electrostatics Ex 13 for answer)